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DEMONSTRATE THE EFFECTIVENESS OF IODINE FOR THE DISINFECTION OF PUBLIC WATER SUPPLIES AND TO DETERMINE THE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION

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Public Health Service
Cincinnati, Ohio

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First Progress Report

of

A Demonstration Project Grant

from

The Division of Water Supply and Pollution Control

Public Health Service

WPD-19-01-63

Object

"To demonstrate the effectiveness of iodine for the disinfection of public water supplies and to determine the physiological effects on a human population."

Dr. A. P. Black, Project Director
and
Research Professor of Chemistry and
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Gainesville, Florida

November, 1963

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Marion County Health Department
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I. Duties and Responsibilities of Project Staff

The medical and clinical work on the project is under the direction of Dr. W. C. Thomas, Jr. He is being assisted by Dr. Edward D. Byrd, Dr. Gerhard Freund, and Charles A. Glover, Jr.

The chemical and engineering aspects of the program are under the direction of the project director, assisted by Riley N. Kinman, Margaret Whittle and R. P. Vogh.

The bacteriological work is under the direction of F. W. Gilcreas and is being done by Pauline Gubbins in the Earle B. Phelps Sanitary Engineering Research Laboratory. In addition, nine weekly samples are being collected by Gene M. Price, Chief Sanitarian of the Marion County Health Department, and mailed to the State Board of Health Laboratories in Jacksonville. When the new Marion County Health Unit Building is completed, this checking work in bacteriology will be performed in that laboratory which is only about ten miles distant from Lowell.

II. Advisory Committee

In a project of this magnitude, it was felt advisable to secure advice and assistance from qualified representatives of the many disciplines involved. Accordingly, an Advisory Committee of twelve active and one ex officio members has been organized and the first meeting of the Committee was held in the offices of the Florida State Board of Health in Jacksonville on February 15. At this first meeting the project was carefully reviewed and basic decisions made on those problems requiring immediate action. A second meeting of the Committee was held at Lowell, Florida, on October 9. All members of the Committee were present, together with several invited guests including Louis L. Wainwright, Director of the Division of Corrections; Mrs. Alyce D. McPherson, Superintendent of Florida School for Girls, and several members of the administrative staff of the three institutions involved in the study. The reconditioned water system with its new equipment was inspected by the group following which, in a three-hour meeting, all aspects of the project were thoroughly discussed and major decisions on a number of items on which decisions were required were reached. Other meetings of the Advisory Committee will be held as required, and progress reports issued, probably on a quarterly basis.

III. Base-Line Bacteriological Studies and Chlorine Residuals

Immediately following the first meeting of the Advisory Committee, a meeting was held in Lowell at which Black, Gilcreas, Kinman, Vogh, Dutton and Price were present, and nine locations in the system were selected for the collection of samples for bacteriological samples. They include samples from each of the three wells and from six strategic locations in the distribution systems. It was further agreed that on Monday of each week the samples would be collected by Kinman for analysis in Phelps Laboratory and on Wednesday of each week samples would be collected

from the same locations for analysis by the State Board of Health, and this program has gone forward steadily since that time. In addition, chlorine residuals have been recorded by Kinman during each sample collection period, and quite frequently at other times. A brief summary of bacteriological data obtained to date is included as Appendix I of this report.

IV. Improvements to Buildings and Equipment

The larger system supplying both the Florida School for Girls and the Women's Correctional Institution comprises two wells which have been designated as No. 1 and No. 2 respectively, a ground storage reservoir having a capacity of approximately 70,000 gallons, an elevated tank having a capacity of approximately 100,000 gallons, and a pump house containing three high-service pumps, a master meter, an air compressor, a chlorinator and a water softener. In addition, there is a 4,000 gallon horizontal steel storage tank originally used with the air compressor as a pneumatic system before the present pumps were installed. To the larger system the following changes and improvements have been made.

1. The air compressor and water softener have been removed from the pump station so as to provide needed room for the new equipment.

2. The master water meter was found to be inoperative and has been returned to the factory and repaired and is now in service, and continuous records of water used are being obtained.

3. Since the two small high-service pumps, having capacities of 55 gpm and 60 gpm respectively, are capable of meeting peak demands, the decision has been made to use only these pumps during the three-year test period and not to use the larger high-service pump with motordriven standby except in an emergency. The two smaller pumps were disassembled and since the impellers were found to be slightly worn, they have been replaced by new impellers. This procedure will permit operating the two pumps at the original designed capacity.

4. Since in case of emergency the larger pump and gasoline engine standby may be required, the exhaust from this unit has been vented to the outside and the liquid fire extinguisher replaced with a new carbon dioxide unit.

5. Since the pump station is below ground, flooding was experienced after heavy rains. Accordingly, a sump was constructed in the pump house and a new sump pump installed. In addition, the area around the station has been graded, nine yards of concrete poured to provide a smooth open-air working area, and 28 feet of concrete-lined ditch and 45 feet of 6 inch vitrified pipe installed, which has solved the drainage problem.

6. A new roof has been erected over both the pump station and considerable adjoining area providing ample outside covered space for installing the air compressor and water softener.

7. The old air compressor was in poor condition so a new one has been purchased and installed at a cost of $125.00.

8. The old pneumatic system has been cleaned and repaired, and with the new air compressor is now in operating condition and available as a standby emergency system.

9. New doors, windows and screens have been installed in the pump house.

10. Finally, both well pump houses and the main pump house have been painted, both inside and outside, together with the ground storage reservoir, the pneumatic tank and all pumps, motors and exposed piping. Different colors have been used to distinguish raw and treated water and the entire system now presents a most attractive appearance.

We have supplied all materials required for these improvements and additions at a total cost of approximately $1,500.00. Superintendent West has made available to Mr. Kinman the services of an average of three to five men per day over a period of approximately two months which is equivalent at prevailing wages to a labor cost of between $3,000 and $5,000, and this substantial assistance is gratefully acknowledged.

The Men's Prison, located approximately one mile east of the two other institutions is almost new and consequently its water system will require no alterations other than the addition of new equipment. It should be mentioned in passing, however, that Mr. Kinman has supervised the cleaning of the boilers in the water system, has prescribed a new method of internal chemical treatment for the boiler water to prevent scale formation and corrosion, and is instructing operating personnel in the proper method of operating this equipment.

V. Installation of New Equipment

A new isotope recorder and automatic titrator for the continuous recording of both chlorine and iodine residuals has been received and was installed by Messrs. Vogh and Kinman on July 6. It was calibrated on July 11 by Messrs. Kinman and Robert Sinn, the Wallace and Tiernan District Representative, and is now in service. It is being employed for the continuous determination and recording of chlorine residuals until iodine feed is first begun, probably in early fall. This equipment, together with a portable amperometric titrator and much accessory equipment and supplies and costing in excess of $4,000, has been furnished the project by the Wallace & Tiernan Company at a nominal rental of $300 per year.

The Marion County Health Department is just completing a new building to house its activities which includes a bacteriology laboratory. Since no funds were available for equipping this laboratory immediately, we have agreed to provide the necessary equipment needed for the bacteriological examination of water samples in return for which the laboratory will routinely collect and analyze nine samples weekly throughout the entire period of the test. This equipment is being purchased, some of it from the Florida Development Commission Surplus Warehouse at Starke at much reduced prices. Total cost of equipment and supplies purchased or to be purchased will be several hundred dollars and will be reported when the figures are available.

All individuals in the test group have received two dosages of radioactive iodine. A number of items of laboratory equipment needed for the clinical examination of these patients has been purchased. The major items are a decade scaler, a scintillation detector with stand, transistorized Cutie Pie survey meter, a labitron, a Leitz microscope, and a two-register printing calculator. Total cost of these items was approximately $4,000.

Metering equipment is to be supplied on a loan basis by Builders-Providence, Inc. of Providence, R. I. and with the assistance of John Miner, Atlanta representative of the company, selection of this equipment has been made and it will be received shortly.

Four stainless steel metering pumps have been installed, two in the Forest Hills pumping station and one at the Men's Prison with the fourth held in reserve. After a few weeks of pumping saturated iodine solution, one of the pumps in service will be replaced with the spare, and the serviced pump completely disassembled and carefully examined for any evidences of corrosion due to iodine solution. Stainless steel pipe and fittings have been used throughout.

The solubility of iodine is temperature-dependent (see table below) to such a degree that it is necessary to maintain the temperature of the saturated solution within plus or minus 1°C in order to obtain uniform feed and dosage. Since the temperature of the well water is practically constant throughout the year at 73°F, it was decided that the simplest method of insuring uniform iodine solution would be to maintain the temperature in the pump room at the same value. Accordingly, a 12,000 BTU reverse cycle air conditioner has been installed, and is capable of maintaining this temperature throughout the year, acting as a heat pump during the winter months and as an air conditioner during the summer months. It has also served as a de-humidifier and has effectively prevented condensation of water on the cool, exposed water pipe during the humid Florida summer season.

Three iodine saturators have been designed and constructed, based upon information gained through numerous laboratory tests during the past few months. The largest of the three has been installed in the pump station at Forest Hills and iodine feed was begun in that water system at 2:30 PM on Monday, October 27. A second feeder is being installed at the Men's Prison and iodine feed in that water system is expected to be operational by November 2.

Solubility of Iodine in Water

Temp., °C.	Soly., g/1000g. H_2O	Temp., °C.	Soly., g/1000g. H_2O
0	0.162	60	1.06
20	0.293	70	1.51
25	0.340	80	2.17
30	0.399	90	3.12
40	0.549	100	4.48
50	0.769	110	6.65

All iodine and potassium iodide required for the project over the three-year period are being supplied without cost by the Chilean Iodine Educational Bureau, Inc. through the courtesy of Mr. H. J. Cordle, Director.

VI. Effect of an Iodinated Water Supply on Thyroid Gland Function and Health of Exposed Individuals.

The major known function of iodine in humans is that it is an essential component of thyroxine, the hormone of the thyroid gland. Ingested iodine is accumulated in the thyroid and subsequently used for hormone production. Iodine is also accumulated by other tissues of the body, e.g. the posterior pituitary and prostate glands, but the role of iodine in these tissues is unknown. Large doses of iodine (1 mg. or more) modify the rate at which the thyroid gland accumulates this element. Even larger doses may induce enlargement of the thyroid and, in susceptible individuals, cause allergic manifestations.

To assess the effect of an iodinated water supply on a selected population thyroid function, blood iodine levels, and general physical health have been assessed in every fifth individual of the study group. The evaluations have been done in duplicate on these subjects prior to iodine exposure and will be repeated at one month, three months, six months and one year after iodination of the water supply. The control, or pre-iodine evaluations have been completed on 133 subjects. Details of the study are as follows:

1. General Outline. Two baseline studies have been completed so far. This part of the study serves the purpose of establishing normal variations of the various procedures before the addition of iodine to the drinking water. The two sets of evaluations were done on the same subjects approximately two months apart.

2. Subjects. Forty adult white males; ten subjects were lost since the beginning of the study, five new subjects were added, leaving a total of 35 male subjects.

Seventy adult white and colored females, none lost. Thirty colored girls, age 13 to 16; three were lost since the start of the study, one new girl was added, leaving a total of twenty-eight subjects. Total number of subjects at present: 133.

3. Parameters studied in every subject at each session:

   (a) History - see attached sample form.
   (b) Physical examination - see attached sample form.
   (c) White blood count, differential smear and hematocrit.
   (d) Serum protein bound iodine, both total and column fractionation for thyroxine.

4. Radioactive Iodine Uptake. Each subject receives a capsule containg 15 microcuries of radioactive I^{131}. A count of the radioactivity over the thyroid gland is taken 24 hours later, compared with a background count over the shielded gland and with a standard capsule and calculated as indicated on the attached form. Iodination of the water began on October 25, 1963, and re-evaluation of all the above parameters in every subject will begin on November 25, 1963.

V. Water Quality

Laboratory work is going forward on the chemical quality of water from each of the three wells. Iodine demand curves are being run weekly on water from each of the wells in order to ascertain whether or not the advent of the rainy season will have any effect upon this important property of the waters to be used. In addition, routine chemical analysis of water samples are being made to evaluate variables other than iodine demand. Determination of the presence and amounts of trace elements by spectrographic or other methods is planned.

Appendix I

Review of Bacteriological Data
February - September 1963

by

F. W. Gilcreas and Pauline Gubbins

Since February of this year samples have been collected and analysed on the Monday of each week from the ten selected locations in the water system at Lowell. These include samples from each of the three wells, two samples each from the women's, girls' and men's dormitories, and one from the station discharge.

The wells are untreated and the chlorine residuals in the other seven sampling points have been very low or altogether absent.

Wells No. 1, 2 and 3

A total of 32 samples have been collected and examined from each of these three wells. The following table shows the number of occasions on which an MPN of 2 or more has been obtained.

Well	MPN/100 ml of 2 or more	Max. MPN/100 ml	Average MPN/100 ml	Max. SPC/1 ml
No. 1	9	130	29	120
No. 2	22	33	15	170
No. 3	4	8	3	170

From the above table it can be seen that periodically Well No. 1 showed evidence of small amounts of contamination; most of this contamination occurred in the period February through May. The relatively high maximum MPN of 130 was not typical as the average MPN of the other contaminated samples was around 29.

Well No. 2 showed quite regularly a small but consistent source of contamination. The pollution was well distributed throughout the six months of sampling and showed no decrease in the latter months.

Well No. 3 was significantly superior in quality. Only very occasionally were very small amounts of contamination detected.

The Dormitories

The samples weekly, making a total of 64, were examined from each of the women's, girls' and men's dormitories. The two sampling points within the

dormitores were varied each week. The following table again shows the incidence of pollution where the MPN was 2 or more.

Dormitory	MPN/100 ml of 2 or more	Max MPN/100 ml	Average MPN/100 ml	Max SPC/1 ml
Women's	14	79	11	100
Girls'	17	>240	33	TNC
Men's	4	13	5	200

Of the 128 samples examined from the women's and girls' dormitories only 31 showed an MPN of 2 or over. The pollution, when it occurred, was not confined to any one of the sampling points within the dormitories which seems to indicate that the pollution was systemic rather than local.

The men's dormitories showed very little contamination throughout the series of tests.

Station Discharge

Of the 32 samples examined from this station there were 11 occasions when contamination was shown. It had a maximum MPN of 130, an average MPN of 45 and a maximum SPC of 260. Most pollution occurred in the first four months and since early July the MPN has been <2.

Conclusions

1. The sanitary quality of all sample points, except Well No. 2, has shown a marked improvement since early July.

2. The water in the men's section, both in the dormitories and Well No. 3, is of superior quality to that examined elsewhere at Lowell.

3. There seems to be some evidence that pollution occurred in the women's and girls' dormitories at the same time that it occurred in Well No. 1 or Well No. 2, or both. Also, more conclusively shown by the results, pollution occurred in the men's dormitories and Well No. 3 at the same time.

Appendix II - A

Iodine Study

NAME: NUMBER:

DATE: AGE: SEX: RACE:

HISTORY

1. Previous Thyroid Disease:

2. Allergies:

3. Skin Rash:

4. Other:

EXAMINATION

Pulse:

Skin:

Thyroid - Size -

Firmness

Regula ity

Appendix II - B

Iodine Study

NAME: NUMBER:

DATE: AGE:

I^{131} Study -
Factor Calculation:

	CPM	Net CPM	Factor D/S
STANDARD for 1 minute			
DOSE for 1 minute			
BACKGROUND for 1 minute			

24 Hour Thyroid Uptake:

	TIME	%	Net %
Standard to 50,000 counts			
Thyroid without shield to standard time			
Thyroid with shield to standard time.			

24 hour % uptake = % $\frac{\text{of standard}}{\text{factor}}$ = _____ %

PBI = _____

BEI = _____